1965

The Effects of Seasonality of Manufactured Milk Production on Dairy Manufacturing Firms' Efficiency

Law Nicholas Brod

THE EFFECTS OF SEASONALITY OF MANUFACTURED MILK PRODUCTION ON DAIRY MANUFACTURING FIRMS' EFFICIENCY

BY

LAW NICHOLAS BROD

A thesis submitted
in partial fulfillment of the requirements for the
degree Master of Science, Major in
Economics, South Dakota
State University

1965

THE EFFECTS OF SEASONALITY OF MANUFACTURED MILK PRODUCTION ON DAIRY MANUFACTURING FIRMS' EFFICIENCY

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Thesis Adviser — Date: June 24, 1965

Head, Economics Department — Date: June 24, 1965

ACKNOWLEDGMENTS

The author wishes to express his sincere appreciation to Mr. Leonard Benning, thesis adviser, for his guidance and suggestions throughout this study. Special thanks are extended to Mr. Robert Antonides, Dr. Robert Beck, and Professor L. T. Smythe for reading the manuscript and presenting constructive criticisms and helpful comments.

Gratitude is expressed to Mrs. Galen Busch for typing the manuscript.

The thesis is dedicated to the author's wife, Connie, whose patience and encouragement during the writing of this thesis was greatly appreciated.

LNB

TABLE OF CONTENTS

	Page
CHAPTER I. INTRODUCTION	1
Objectives	2
Procedure	2
Application of Theory of the Firm to Cooperatives	5
Short Run Costs and Flexibility at Operation	6
CHAPTER II. REVIEW OF LITERATURE	8
Seasonality and Costs	8
CHAPTER III. FINDINGS OF THE STUDY	16
Milk Receipts and Operating Capacity	16
Milk Receipts	16
Operating Capacity	17
Plant Operating Costs	21
Labor Costs	21
Total Labor Costs	24
Fuel and Utilities Costs	26
Building and Equipment Costs	28
Administrative Expense	31
Operating Supplies	33
Total Plant Operating Costs	33
Butter and Powder Manufacturing Costs	37

Page

CHAPTER IV. A COMPARISON OF IN-PLANT COSTS BY MAINTAINING MILK RECEIPTS AT SEASONAL, AVERAGE, AND PEAK LEVELS. 42

In-Plant Costs and Peak Receipts. 42

In-Plant Costs and Average Receipts 43

Economic Implications 45

Reliability of the Results. 48

CHAPTER V. SUMMARY AND CONCLUSIONS. 49

Summary 49

Conclusions 51

LITERATURE CITED 53

LIST OF FIGURES

Figure		Page
1.	Monthly Milk Production, South Dakota	3
2.	A Graphical Extension of Theory of the Firm to Cooperative Enterprise	6

LIST OF TABLES

Table		Page
1.	Monthly milk receipts of the surveyed plants, 1963.	18
2.	Average total milk receipts and seasonal variation during the months of highest, lowest, and average volume.	19
3.	Percentages of plant capacity used during months of high, low, and normal volume.	21
4.	Labor force at six South Dakota milk manufacturing plants, 1963.	23
5.	Wage rates, skilled and other, at six South Dakota milk manufacturing plants, 1963	23
6.	Average total labor costs per month and per 100 pounds of milk processed at six South Dakota milk manufacturing plants, 1963	25
7.	Average total monthly fuel, electricity, and water costs per month and per 100 pounds of milk processed at six South Dakota manufacturing plants, 1963.	27
8.	Average total building and equipment cost per month per 100 pounds of milk processed at six South Dakota manufacturing plants, 1963	30
9.	Average total administrative expenses and cost per 100 pounds of milk processed at six South Dakota manufacturing plants, 1963.	32
10.	Average total cost of operating supplies and cost per 100 pounds of milk processed at six South Dakota manufacturing plants, 1963	32
11.	Summary of the average monthly plant operating costs and cost per 100 pounds of milk processed at six South Dakota manufacturing plants, 1963	34
12.	Summary of total unit costs classified as fixed, semi-variable or variable at six South Dakota milk manufacturing plants, 1963	36

Table Page

13. Total pounds of butter manufactured per month at six South Dakota milk manufacturing plants, 1963. 38

14. Total pounds of powder manufactured per month at six South Dakota milk manufacturing plants, 1963. 38

15. Average total cost of butter manufacturing and cost per 100 pounds of milk processed at six South Dakota milk manufacturing plants. 39

16. Average total cost of powder manufacturing and cost per 100 pounds of milk processed at six South Dakota milk manufacturing plants. 39

17. Increase in milk receipts and total costs by operating with peak receipts at six South Dakota milk manufacturing plants, 1963. 42

18. A comparison of in-plant unit costs under conditions of seasonally fluctuating, even, and peak monthly milk receipts at six South Dakota milk manufacturing plants, 1963. 44

19. Wholesale manufacturing milk prices, South Dakota . . 46

20. Premiums available through savings in in-plant costs at six South Dakota milk manufacturing plants, 1963. 46

CHAPTER I

INTRODUCTION

Seasonal variations in milk production have been a major problem of the South Dakota dairy manufacturing industry for a number of years. Processors faced throughout the year with wide fluctuations in the volume of milk received are prevented from obtaining optimum utilization of equipment, labor, and other plant facilities. Manufacturers cannot decrease operating costs materially as volume declines from peak levels since a major portion of the plant's costs are fixed. Unit costs, the cost of manufacturing 100 pounds of milk, tend to be higher as the volume of milk received decreases. Although it may be possible for the plant to adjust as volume decreases, sharp reductions in the amount of milk received prevents full use of the plant facilities.

The above generally indicates the nature of this study. How then, is South Dakota affected by this problem? In 1959, the cash farm income from South Dakota dairy products totaled $35,255,000 or 5.5% of the total farm income; in 1962, this figure had risen slightly to $37,776,600 or 5.6%.[1] These figures alone, however, cannot show the importance of the dairy industry. In relation to other forms of cash farm income, the dairy industry in 1962 ranked

---

[1] South Dakota Crop and Livestock Reporting Service, South Dakota Agriculture, 1963, p. 47.

fifth out of a possible 22 different forms of cash farm income, yielding only to the cattle, hog, corn and wheat industries.

Seasonality of milk production in South Dakota is decreasing, but the rate of decrease has not been sufficient to eliminate the existing problem nor has it been consistent over the last several years. For example, in 1957, 97 million pounds of milk were produced in South Dakota in the month of January as compared to 165 million pounds in June; in 1960, 113 million pounds were produced in January as compared to 148 million pounds in June; and in 1963, 99 million pounds of milk were produced in January as compared to 148 million pounds in June (Figure 1).

Objectives

The objectives of this study were: (1) to determine the degree of increased efficiency of the firm which might be expected to result from reducing the seasonal variations of milk production and increasing receipts to a level now attained only three months of the year, (2) to estimate the effect of increased efficiency of the firm on producer milk prices.

Procedure

Emphasis in this study was on in-plant costs in milk manufacturing under various seasonal patterns of milk receipts. Scale of production, equipment capacity, and costs (fixed and variable)

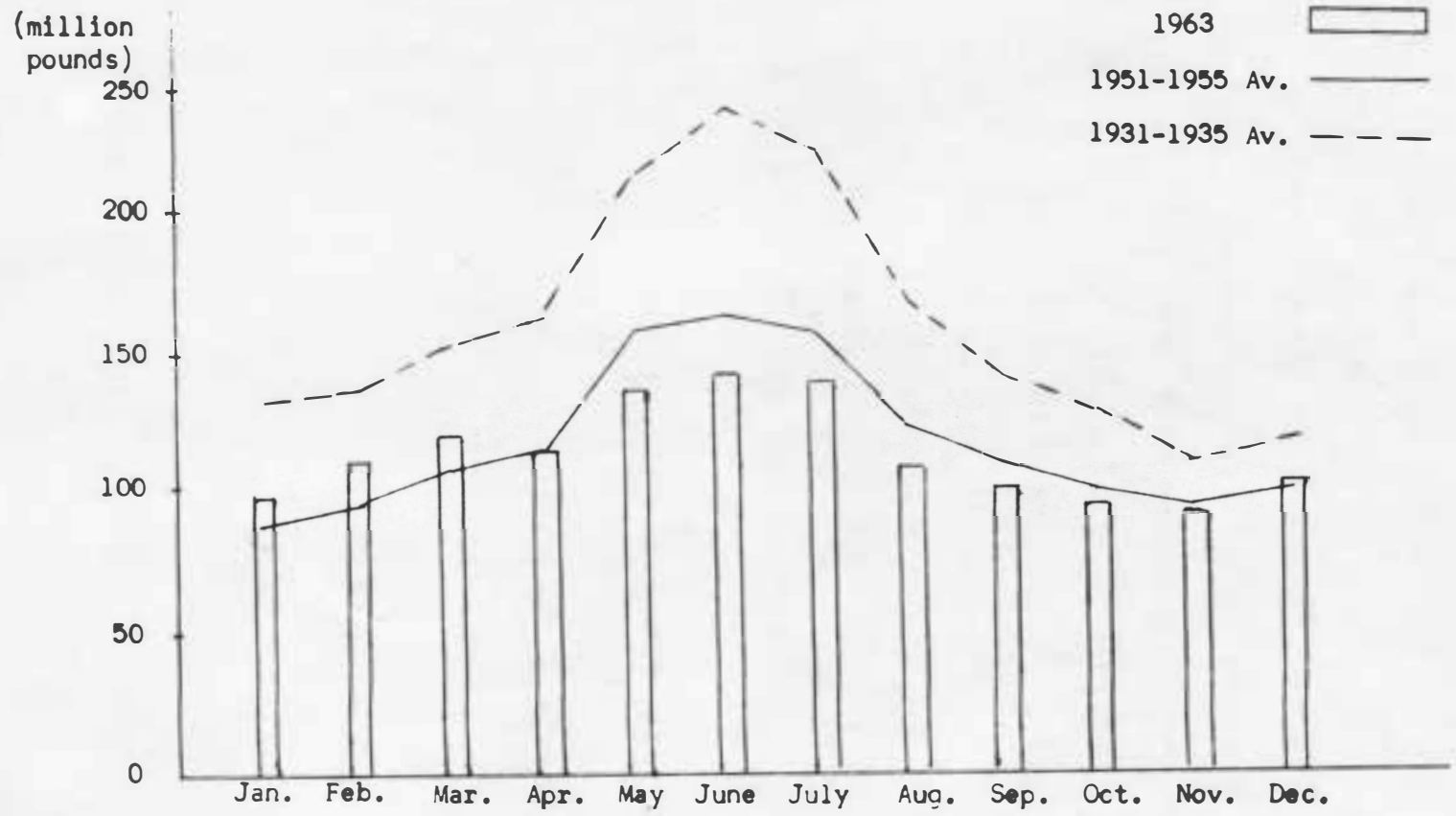

Fig. 1. Monthly Milk Production, South Dakota

Source: South Dakota Crop and Livestock Reporting Service, South Dakota Agriculture, 1963.

were considered only with respect to their effect on efficient plant operation during a one-year period.

Included in the original survey were five butter-powder plants and one powder plant. All of the plants are located in Eastern South Dakota. Five plants are cooperatives, while one is a conventional corporation. The survey included all of South Dakota's butter-powder plants. Data collected was analyzed to determine the effect of volume variability on plant operational costs. All of the plants included in the final analyses had in common the problem of maintaining as efficient an operation as possible under conditions of seasonal milk and cream procurement.

In order to determine how the six firms' costs varied under the impact of seasonal milk and cream procurement programs, detailed records were taken of milk receipts and plant costs for each month of the year 1963. Preliminary investigation in a milk diversion plant showed that adequate monthly records were available to allow the measurement of seasonal milk variations and plant costs.

In order to acquire the production and cost data needed and to obtain additional information, a questionnaire was completed at each of the six South Dakota dairy manufacturing plants surveyed. To determine managers' attitudes as to the degree the problem of seasonality represents, part of the questionnaire was constructed to include an area for a depth-type attitudinal interview. Unstructured questions included each manager's attitude towards the problem of

seasonality, whether they considered seasonality an important problem, and, or if, they were in favor of a plan to level out the variation. Structured questions covered a broad range including -- general information about the plant and plant equipment, products manufactured, plant receipts, and plant operating costs.

Application of Theory of the Firm to Cooperatives

In order to evaluate the results of this study it was necessary to formulate the problem in such a way as to make possible meaningful comparisons between cooperatives and conventional corporations. The theory of the firm is based on the concept of profit maximization. If all of the plants included in this study were conventional corporations, the principle of profit maximization would be inherent in their operation. Actually, however, only one of the six plants is a conventional corporation. The remaining five are cooperatives operating on a nonprofit basis.

The difference between a cooperative and a conventional corporation is illustrated in Figure 2. The distance OA is to the left of the maximum points of MR and AR because of the inability of dairy plants to approach optimum scale. If Figure 2 represented conventional corporations and the buying price was held at AT, each plant would enjoy profits equalling STUV. Cooperatives, operating with these same curves, would pay the prevailing price AT, plus a patronage dividend of TU. However, if the surplus TU was distributed

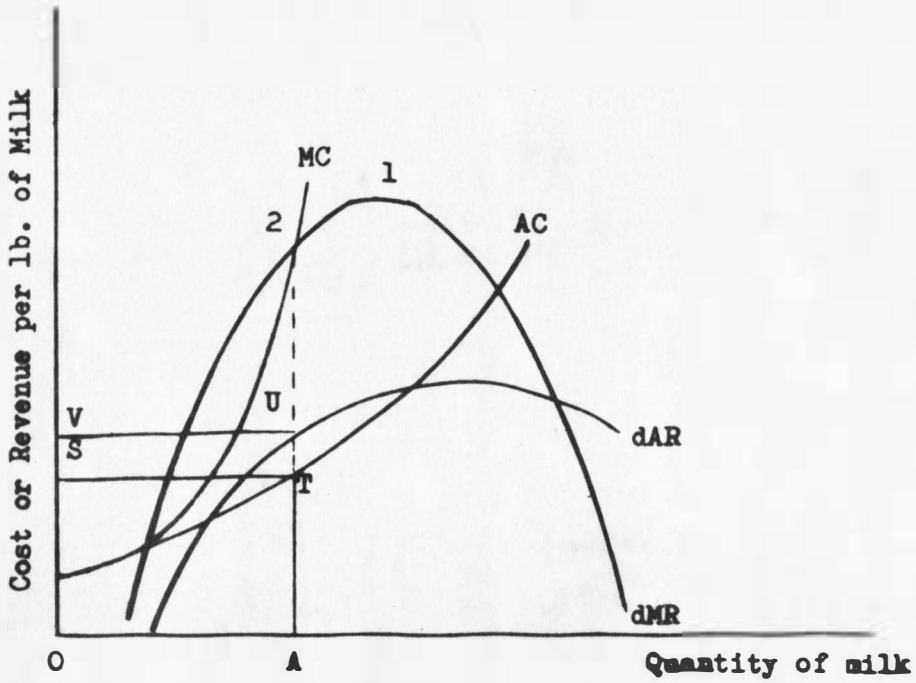

Fig. 2. A Graphical Extension of Theory of the Firm to Cooperative Enterprise.[2]

on the basis of ownership of capital without regard to volume of patronage, a cooperative's operation would be no different from that of a strictly conventional corporation.

Short Run Costs and Flexibility of Operation

The long run curve of average cost is the curve of economies of scale dependent upon the adjustment of scale of a plant to successive volumes of operation. In a long run analysis there are no fixed costs as there is sufficient time involved for any necessary

---

[2] William H. Nichols, Imperfect Competition Within Agricultural Industries, (Iowa State College Press, Ames, Iowa, 1941) p. 225.

adjustments in scale that have to be made. Fixed costs, in other words, in the long run become variable costs.

Throughout this study consideration is given to the nature of costs within a short period, during which the scale of the plant is regarded as fixed rather than variable. This implies that only technical changes can be made that do not alter the scale of the plant. Costs become then: fixed costs, which do not vary in the aggregate as volume increases, and variable costs, which do vary aggregately with volume. Examples of fixed costs include buildings and equipment, while variable costs relate to such factors as labor and supplies.

Seasonal fluctuation in the volume of milk received is a regular phenomena dairy manufacturing plants must face. Due to the certainty of seasonal receipts, flexibility is built into the plants. A plant certain to operate at X units of input per week will undoubtedly have lower costs at that volume than will a plant designed to be passably efficient from X/2 to 2X units per week. Such plants, however, are necessary in the dairy manufacturing industry.

CHAPTER II

REVIEW OF LITERATURE

There is available an ample supply of literature that pertains to the problem of seasonality in the dairy industry. A large percentage of the publications, however, are concerned only with one particular aspect of the seasonal problem, and their findings in these areas are secondary to analyses undertaken for other purposes. These particular areas of research include; the seasonality of prices paid, milk received, butter manufactured, and dry milk products. Most studies concentrated on one of these factors, several on more than one, and very few on all of the factors. As this paper is an attempt at an analysis including all of these factors, the following review endeavors to analyze completed research insofar as seasonality is related to dairy products manufacturing. This review of literature is limited to that research which analyzes costs and efficiency within dairy manufacturing plants under seasonal conditions.

Seasonality and Costs

Fitzpatrick, in a recent study, determined the relative cost of labor in the manufacture of dairy products.[3/] His study revealed

---

3/ John M. Fitzpatrick, Impact of Seasonality of Milk Supplies on Labor Costs and Efficiency in Dairy Manufacturing Plants, (Ph.D. dissertation, Purdue University, Lafayette, Indiana, 1963), p. 7.

that labor is a small cost compared to other imputs comprising the total manufacturing costs. Fitzpatrick indicated that savings in labor expenses by leveling out the seasonality may not prove feasible as increases in raw material costs may offset the savings in labor. Prices in Indiana can vary by as much as 60 cents per hundredweight of milk. In-plant labor savings in themselves would not be sufficient to compensate for this additional cost. Fitzpatrick admits, however, that a study encompassing all of the in-plant costs may provide areas from which advantages may be seen in the leveling out of milk receipts.

Lacasse and Spencer made an analysis of the costs and efficiency in the operation of milk manufacturing plants in the New York-New Jersey milkshed.[4/] Their purpose was to develop information that would contribute toward more efficient operation of manufacturing plants. Attention was given to the manufacturing costs of the cream and dry milk operations with special emphasis on the effect of plant size and seasonality of supply on operating costs.

Lacasse and Spencer found that the volume of milk receipts at all the plants studied displayed wide seasonal fluctuations. The authors concluded however,

---

[4/] Armand Lacasse and Leland Spencer, Costs and Efficiency in the Operation of Milk Manufacturing Plants in the New York-New Jersey Milkshed, A. E. - Res. -26 (Department of Agricultural Economics, Cornell University, Ithaca, New York, 1960).

> That even with quite limited changes in the physical facilities, important cost savings could be realized in these plants through some rearrangement of the equipment in certain areas of the plants and by the introduction of additional labor-saving devices.5/

The authors also inferred that additional savings could be expected from a more even supply of milk throughout the year.

Owens and Clark, in a marketing research report, synthesized three basic types of dairy plants: the receiving station, the cheese plant, and the cream-nonfat dry milk plant.6/ Their objectives were to analyze costs and determine costs which would be consistent with reasonably efficient operations in the New York-New Jersey milkshed. The costs determined by the authors represented what they felt was a level attainable under conditions of efficient organization.

Owens and Clark's study took into account that all plants are faced with seasonal patterns in milk procurement and they demonstrated with the use of a model the costs that each size plant could expect at various times of the year. The authors' model plant illustrated the lower costs experienced during the months of full capacity in comparison to months with low receipts.

5/ Ibid., pp. 42.

6/ T. R. Owens and D. A. Clark, Jr., Class III Milk in the New York III-Costs of Manufacturing Dairy Products, Marketing Research Report No. 400, (U. S. Department of Agriculture, Agriculture Marketing Service, 1958).

Owens and Clark, however, considered seasonality as only one factor contributing to wide fluctuations in costs.

Johnson, Forker, and Clarke, in 1964, published a report on the operations of dairy plants in California.[1] The report presents a description of the manufactured dairy products industry. Along much the same line as Owens and Clark, these authors synthesized several California dairy manufacturing plants with the purpose of estimating comparative costs of processing milk into manufactured dairy products under conditions of seasonal production.

Johnson, Forker, and Clarkes' study revealed that the California dairy industry experiences wide fluctuations in milk production. Due to the seasonal variations in milk receipts, plants involved in the study operated at peak capacity only in May and June of each year. During the remaining months plants operate just a sufficient number of days to utilize existing capacity. The authors point out that as a result of the seasonal variation of milk receipts a general principle is required of supplying enough capacity to allow each kind of plant to process peak receipts of milk, even though this level is reached only in two months of each year.

---

[1] Aaron C. Johnson, Orlon D. Forker, and D. A. Clarke, Jr., Operations and Costs of Manufacturing Dairy Products in California, Gianni Foundation Research Report No. 272 (California Agricultural Experiment Station, Berkeley, California, Jan., 1964).

Walker, Preston, and Nelson undertook a study in 1953 of analyzing and developing cost standards that would be useful to plant managers in making decisions relative to means of increasing efficiencies of plant operation.[8] Plants included in this study had adequate physical facilities to handle the seasonal peak, but operated at less than a fair degree of efficiency the rest of the year. For all plants, average receipts during November, December, and January were 63 percent of the average receipts of May, June and July.

The results of the Walker, Preston, and Nelson study demonstrated that total average costs became higher as milk receipts decreased. For example, in one plant the average cost of processing 1,000 pounds of milk into butter and powder, when the plant operated at full capacity, was $4.23. However, when operating during the months of lowest milk receipts, the average cost per 1,000 pounds of milk manufactured of this same plant was $5.54. This represents a difference between months of high and low receipts of $1.21 per 1,000 pounds of milk processed.[9] This same pattern of average costs was found to exist in all of the plants included in the author's study.

---

[8] Scott H. Walker, Homer J. Preston, and Glen T. Nelson, An Economic Analysis of Butter-Nonfat Dry Milk Plants, Bulletin No. 20 (Western Regional Research Publication, University of Idaho, June, 1953).

[9] Ibid., p. 47.

The principle conclusions of the Walker, Preston, and Nelson study are:

1. Within a given plant the efficiency of the plant increases, as volumes of milk processed increase up to and including the practical capacity of the plant.
2. Under existing technical processes, butter-powder manufacturing appears to be a decreasing cost industry.

Two other studies that approach the problem of seasonality in a similar fashion as those above are Bartlett and Gothard's Illinois study[10] and Frazer, Nielson and Nord's Iowa study.[11]

The Illinois study indicates two factors of major importance affecting efficiency within the plant: (1) efficiency in the use of labor tends to increase as volume increases, and (2) volume alone is not a dependable measure of efficiency.[12] What the second factor refers to is that plant equipment and the number of products, as well as volume, all contribute to efficient plant operations. The greatest opportunities for improving milk-plant efficiency appear to the authors to lie in: increasing volume, modernizing

---

[10] R. W. Bartlett and F. T. Gothard, Measuring Efficiency of Milk Plant Operation, Bulletin 560 (University of Illinois, Nov. 1952).

[11] J. R. Frazer, V. H. Nielsen and J. D. Nords, The Cost of Manufacturing Butter, Research Bulletin 389 (Iowa State College, June, 1952).

[12] Op. cit., Bartlett and Gothard, p. 6.

equipment, modernizing the plant layout, and limiting the number of products.

The Iowa study was a part of a broad study designed to determine effective methods of marketing the milk produced on Iowa farms. This study also examines the costs of manufacturing butter in Iowa creameries. The sample used was composed of very small plants with annual production ranging from less than 200,000 to over 2,000,000 pounds of butter.

Frazer, Nielsen, and Nord found three distinct cost phases that coincide with increased volume. The first phase consisted of plants somewhat smaller than average size that experienced rapidly decreasing unit costs as volume increased. Medium-sized plants were essentially constant cost operations, while very large plants were ones with slowly decreasing unit costs. It was not unusual for small plants to have manufacturing costs of 8 to 10 cents per pound of butter. By increasing volume the smaller plants could decrease unit costs to approximately 4 cents per pound.[13/] The largest creameries achieved the lowest operating costs.

The seven studies reviewed have much in common. Most of the cost studies were primarily descriptive, but ventured conclusions regarding economies of scale. The figures of each study showed

---

13/ Op. cit., Frazer, Nielsen and Nord, p. 17.

the behavior of costs with increasing volume. A tendency for average costs to be reduced with increasing volume was evident. This tendency may have been due to efficient use of plant and labor arising from better utilization of capacity or it may have been due to true economies of scale. Each study, however, recognized the influence of seasonal volume of plant costs.

CHAPTER III

FINDINGS OF THE STUDY

Milk Receipts and Operating Capacity

To fully understand the relationship of in-plant costs and seasonality within the six observed plants, some knowledge of the nature of the plants and their operations is necessary. Although the plants differ greatly in a number of important respects, they have many common features.

Milk Receipts

Only one manager of the six surveyed plants considered operations below normal during 1963. Manufactured milk receipts in one plant were lower in 1963 than in previous years. However, the six plants combined received nearly 433 million pounds of milk during the calendar year 1963. The range in total receipts among the plants was from about 43 to 131 million pounds.

Seasonal variations in milk receipts were large. Milk receipts during the three months of lowest production averaged only about 62 percent of receipts in the three months of highest production.[12/] The two plants with the greatest volume experienced the largest seasonal variation. Low-month receipts were only 57

12/ Throughout this study, reference is made to the three high volume months and three low volume months based on total milk receipts. These months were not the same for all the plants.

percent of the receipt of the high-volume month in one plant and 60 percent in the other. During the three months of highest receipts, two plants averaged more than 11 million pounds of manufactured milk per month, two received over 7 million pounds per month, and the remaining two received each month over 4 million pounds. Monthly milk receipts for each plant during 1963 are shown in Table 1. Variations of receipts of each plant studied are shown in Table 2. During the three months of lowest production, receipts dropped to a low of less than 3 million pounds in one plant, and in no plant did receipts reach 9 million pounds per month.

A high percentage of the milk received by these six plants, as shown in Table 2, came directly from producers. The two largest plants received slightly less milk from producers than did the smaller plants.[13/] One plant received 100 percent of its milk from individual producers, while the lowest was 66 percent. During the months of lowest production, the amount of milk from other plants declined and plants became more dependent on their own producers.

Operating Capacity

Each respondent plant in the survey reported the various types and capacities of equipment on hand in 1963. Capacities of equipment were measured in terms of raw product input. By applying capacity to the number of hours of use, a means was provided to

---

13/ The three largest plants based on total milk receipts were A, B, and C in that order.

Table 1. Monthly milk receipts of the surveyed plants, 1963.

Total Receipts - - in 1,000 lbs.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Av.
A.	11,149	12,913	11,228	12,356	15,314	13,697	10,557	10,769	8,615	7,640	7,769	9,674	10,973
B.	8,095	8,525	9,880	10,408	11,638	11,324	10,406	8,529	6,771	6,583	6,787	6,798	8,896
C.	4,848	4,888	5,745	6,315	7,312	7,323	6,734	6,127	5,404	5,248	5,263	5,000	5,850
D.	3,236	3,277	3,876	4,012	4,516	4,352	4,391	4,321	3,353	3,265	3,339	4,086	3,836
E.	3,782	3,706	4,696	4,790	4,767	4,404	3,902	3,225	2,853	2,861	2,793	3,279	3,755
F.	4,737	5,071	5,723	5,979	6,945	7,324	6,374	6,031	4,166	4,060	3,958	4,137	5,375

Receipts From Individual Producers - - in 1,000 lbs.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Av.
A.	8,593	9,303	8,720	8,960	9,569	8,710	7,474	7,554	5,965	5,483	6,011	7,685	7,835
B.	5,917	6,174	7,111	7,374	7,929	7,666	6,981	5,705	5,114	5,297	5,430	6,343	6,420
C.	4,848	4,888	5,745	6,115	6,882	6,803	6,334	5,827	4,981	4,899	4,870	5,000	5,599
D.	3,236	3,277	3,876	4,012	4,516	4,352	4,391	4,321	3,353	3,265	3,339	4,086	3,836
E.	3,610	3,541	4,507	4,594	4,569	4,252	3,761	3,094	2,732	2,727	2,653	3,124	3,597
F.	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-

Receipts From Other Plants - - in 1,000 lbs.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Av.
A.	2,556	3,610	2,508	3,396	5,746	4,987	3,083	3,215	2,650	2,157	1,758	1,989	3,138
B.	2,177	2,350	2,769	3,034	3,708	3,657	3,425	2,823	1,656	1,286	1,356	1,455	2,475
C.	-0-	-0-	-0-	200	430	520	400	300	423	349	393	-0-	252
D.	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-
E.	172	165	189	196	197	151	140	130	121	134	140	154	157
F.	4,737	5,071	5,723	5,979	6,945	7,324	6,374	6,031	4,166	4,060	3,958	4,137	5,375

Table 2. Average total milk receipts and seasonal variation during the months of highest, lowest, and average volume.

Item	A	B	C	D	E	F	Average
				Amount per month in 1,000 lbs.			
Total Milk Receipts:							
Three high volume months	13,975	11,124	7,124	4,420	4,751	6,881	8,045
Three low volume months	8,009	6,712	4,912	3,260	2,836	4,052	4,963
Average volume months	10,956	8,873	5,684	3,832	3,832	5,250	6,404
Total Milk Receipts from producers:							
Three high volume months	9,277	7,657	6,674	4,420	4,557	-0-	5,680
Three low volume months	5,820	5,372	4,869	3,260	2,704	-0-	3,671
Average volume months	8,123	6,327	5,428	3,832	3,564	-0-	4,545
				Percent			
Receipts from producers in percent of total milk receipts:							
Three high volume months	66	69	93	100	96	-0-	71
Three low volume months	73	80	99	100	95	-0-	74
Average volume months	74	71	95	100	93	-0-	72
Seasonality of total receipts; three low volume months in percent of:							
Three high volume months	57	60	69	74	60	59	63
Average volume months	73	76	86	85	74	77	78

estimate fairly accurately plant operating capacity. In determining the monthly capacity for each plant, consideration was given mainly to the number of pounds per hour at which each evaporator could operate and the number of plant operating hours each month.

Plant-operating hours varied considerably from plant to plant. Variations in the number of hours each plant operated were due primarily to the time needed for washing and cleaning equipment.[14/] During months of highest receipts, operating hours ranged from a low of 15 hours per day to a high of 22 hours per day. The weighted average was 20 hours per day. During the months of lowest volume the range was broader, beginning with one plant operating 9 hours per day to a high of 20 hours. One plant operated 20 hours per day all 12 months.

Table 3 shows the percentages of manufacturing capacity for each of the six plants. Only three of the six plants had volume high enough to approximate full capacity. When receipts were at their lowest, plant capacity utilization was extremely low. During the months of lowest milk receipts, two plants utilized slightly more than 70 percent of their capacity, while the remaining plants averaged approximately 50 percent of their capacity. The weighted averages show that during months of low volume only 56 percent of the possible capacity was used at the various plants.

14/ Previous studies have determined the maximum possible operating time to be 18-20 hours per day.

Table 3. Percentages of plant capacity used during months of high, low, and normal volume.

Item	A	B	C	D	E	F	Weighted Average
Three high volume months	67	100	100	71	100	85	86
Three low volume months	38	65	77	53	71	49	56
Average volume months	52	83	92	69	92	61	69

For three of the six plants, the average daily quantities of milk received in the high volume months were approximately equivalent to the plants' capacity. Three plants, however, did not fully utilize their equipment and capacity during the period of peak receipts. The range of these plants was from a low of 67 percent to a high of 85 percent.

Plant Operating Costs

The in-plant operating costs were divided into five different categories: labor cost; fuel and utilities cost; building and equipment cost; operating supplies; and administrative expense. In this section a comparison is made of these five different costs during months of high and low production.

Labor Costs

Labor constitutes the largest single item of plant costs in each operation. Labor wage rates varied from one plant to another

due to a difference in local wage scales, local labor supplies, and other factors. Included in the labor costs are salaries, wages, and miscellaneous labor costs including social security and group insurance.

It was found that the larger plants had larger in-plant labor forces. The two largest plants, A and B, employed nearly twice the number of workers as the three medium sized plants, C, D and E. The range in the average size of in-plant labor during months of average receipts was from a low of 7 employees in Plant F to a high of 43 employees in Plant A.[15/]

Seasonal variations from Table 4 can also be noted. On the average, the total number of employees per plant was reduced from 27 during high production months to 22 during low production. The low turnover of employees in relation to the wide seasonal fluctuation in receipts is due to the structural framework of labor in a dairy plant. Specific functions must be performed whether volume is high or low, and such functions require a certain number of employees. Although the labor forces in all plants did fluctuate somewhat as milk receipts varied, the requirements for operators of the separators and driers, as well as employees qualified for work on receiving decks remained constant throughout the entire year.

15/ Plant F had a much smaller labor force than the other plants because the only product manufactured was powder, which eliminated the labor needed in the manufacturing of butter.

Table 4. Labor force at six South Dakota milk manufacturing plants, 1963.

	A	B	C	D	E	F	Average for 6 plants
	- - - - - Number of employees - - - - -						
Service Centers:							
Office	9.0	5.5	3.0	3.5	4.0	1.5	4
Laboratory	1.0	2.0	2.0	.5	.5	.5	1
General Maintenance	2.0	1.5	1.0	1.0	.5	1.0	1
Total	12	9	6	5	5	3	6
Operating Centers:							
High volume month	38	32	22	10	15	5	20
Low volume month	30	27	20	6	13	4	16
Average volume month	31	29	20	8	14	4	17
Total Plant Employees:							
High volume month	50	41	28	15	20	8	27
Low volume month	42	36	26	6	18	7	22
Average volume month	43	38	26	13	19	7	24

Table 5. Wage rates, skilled and other, at six South Dakota milk manufacturing plants, 1963.

							Typical rate
Wage rates per hour:							
Skilled labor	2.20	1.55	1.55	1.65	1.75	2.10	1.80
Other labor							
Usual rate	1.85	1.35	1.30	1.35	1.25	1.40	1.41
Starting rate	1.55	1.25	1.30	1.25	1.25	1.25	1.30
Night premium:							
Second shift	-0-	.10	.05	.10	-0-	.10	.10
Third shift	-0-	..10	.05	.10	-0-	.10	.10

Wages paid employees varied from plant to plant. Table 5 lists the wage rates of each plant. With the exception of Plant A, the rates for both skilled and unskilled labor ran relatively close between plants. Plant A, because of location and competition, was forced to pay higher wages; as a general rule a premium of 10 cents was paid for night work.

Total Labor Costs

A significant variation in total labor costs among the six plants was evident. Table 6 illustrates the variation in labor costs in both absolute terms and percentages.

By examining Table 6, it is clear that there is a correlation between sizes of the plant and labor costs. The total labor cost of the three largest plants, A, B, and C, were larger than the other three plants included in the study. The range in average total costs during the months of highest receipts was from a low of $3,290 in Plant F to a high of $18,531 in Plant A.

Considering each plant, total labor costs tended to vary slightly and from month to month. The average total labor cost during the months of low volume remain, in four of the six plants, 80 percent of the total labor cost during the high volume months. The average for all six plants was 86 percent. Because management is forced to retain most of the labor force year-round, labor efficiency is low during the months of low volume.

Table 6. Average total labor costs per month and per 100 pounds of milk processed at six South Dakota milk manufacturing plants, 1963.

Item	A	B	C	D	E	F	Weighted* Average
	- - - - - - - - - - - Amount per month - - - - - - - - - - -						
Total Labor Cost:							
Three high volume months	18,531	9,551	8,177	6,300	6,971	3,290	10,512
Three low volume months	17,152	8,832	6,926	5,019	5,461	2,058	9,109
Average volume months	19,994	9,040	7,625	5,710	6,484	2,433	10,153
Misc. Labor Costs:							
Three high volume months	1,544	1,132	1,186	419	1,217	401	1,097
Three low volume months	1,101	985	1,133	386	1,124	311	895
Average volume months	1,627	910	1,031	412	1,162	330	1,031
Total Labor Cost of Low Volume Months as Percent of:	- - - - - - - - - - - - - - Percent - - - - - - - - - - - - - -						
Three high volume months	93	93	85	80	78	63	86
Average volume months	86	98	91	88	84	85	89
Unit Labor Cost:	- - - - - - - - - Amount per 100 pounds - - - - - - - - -						
Three high volume months	.133	.086	.115	.143	.147	.048	.112
Three low volume months	.214	.132	.141	.154	.193	.051	.163
Average volume months	.182	.102	.100	.153	.169	.046	.130

* Weighted against the volume of milk.

Labor costs per 100 pounds of milk processed are also shown in Table 6. The amount of labor cost per hundredweight of milk manufactured varied among the six plants and showed definite seasonal changes. The greatest change in unit costs of labor from months of low receipts to months of high receipts was 8 cents in Plant A; the lowest was in Plant F, which experienced very little unit-cost seasonality. The average change of all plants was 5.1 cents. Lowest unit costs during the months of highest volume were sustained by the two largest plants, A and B, while during the months of low volume, unit costs in the large plants increased substantially compared to the smaller plants. Total unit labor costs in the months of normal volume were 13 cents per hundredweight of milk manufactured, which was slightly above the peak receipts months, and under the low receipts months.

Fuel and Utilities Costs

The principal utilities used in the manufacture of dairy products are electricity, water, and natural gas. In each stage of operation, electricity is needed to operate motors of major pieces of equipment and compressors used in refrigeration. Water is used mainly in clean-up. Fuel, which is mainly natural gas, is used to heat the building but also is needed to provide steam for pasteurization, drying, and cleaning. Table 7 lists the average monthly total costs for fuel, electricity, and water, with a breakdown

Table 7. Average total monthly fuel, electricity, and water costs per month and per 100 pounds of milk processed at six South Dakota manufacturing plants, 1963.

Item	A	B	C	D	E	F	Weighted* Average
	- - - - - - - - - - - Amount per month - - - - - - - - - - -						
Total Fuel, Electricity & Water Costs:							
Three high volume months	8,574	5,754	4,923	6,357	4,160	5,768	6,341
Three low volume months	6,239	4,374	4,922	4,471	2,944	4,324	4,822
Average volume months	8,110	5,465	4,475	5,564	4,182	4,901	6,326
Total Fuel Cost:							
Three high volume months	5,390	3,280	3,442	4,512	2,381	4,736	4,155
Three low volume months	3,536	2,624	3,245	3,135	1,171	3,424	2,998
Average volume months	5,494	5,399	2,925	3,901	2,521	3,947	4,410
Total Electricity & Water Costs:							
Three high volume months	3,183	2,473	1,679	1,845	1,679	1,031	2,220
Three low volume months	2,701	1,722	1,481	1,335	1,802	899	1,798
Average volume months	2,617	2,055	1,566	1,662	1,695	953	1,919
	- - - - - - - - - - - - - - percent - - - - - - - - - - - - - -						
Low Volume Total Cost in Percent of:							
Three high volume months	73	76	99	68	70	75	77
Average volume months	94	59	109	80	70	88	84
	- - - - - - - - - - Amount per 100 pounds - - - - - - - - - -						
Unit Cost of Fuel, Electricity, and Water:							
Three high volume months	.062	.052	.069	.144	.088	.084	.073
Three low volume months	.078	.065	.100	.141	.104	.107	.091
Average volume months	.074	.061	.079	.145	.103	.093	.088

* Weighted against the volume of milk.

according to total costs for each utility. Water is such a small cost it was included with the cost of electricity.

For the normal volume months the average total cost of fuel, electricity, and water amounted to $6,326. The seasonality of total costs ran from $4,822 during the months of low volume to a high of $6,341 during the high volume months. The percentages of low volume total cost to high and average volume indicates that fuel, electricity, and water costs fluctuate with milk receipts. Plant C, however, had costs during the low months that were 99 percent of the costs of the high months. On the average, costs of the low-volume months were only 77 percent of the high months and 84 percent of the normal volume months.

By the use of unit costs a true picture of the impact of seasonal receipts on fuel, electricity, and water costs is exhibited. On the average for the six plants, unit cost of fuel, electricity, and water amounted very close to 2 cents more per hundred pounds of milk in the low volume months than in the high volume months. A comparison of the plants revealed a range of unit costs from a low of 6 cents per hundred pounds during months of normal production to a high of 14.5 cents.

Building and Equipment Costs

Included in building and equipment costs are depreciation, insurance and taxes, and maintenance and repairs. What characterizes this group of costs from the others is that they are fixed inasmuch

as they do not vary with the volume of milk. Any variation of these costs within each plant is due to factors other than seasonality.

Depreciation in all the plants was a uniform rate charged against the original value of the building. The variations in the size of the depreciation allowance between the plants was due mainly to the age and size of the building. Maintenance and repair differences were also due to this same factor. The size of insurance and tax costs was mainly a function of the location of the plant.

As shown in Table 8, the average total building and equipment cost for all six plants during months of normal production was $9,291. The range was from $6,358 to $14,858. The slight difference between the average totals of the high, low, and normal volume months is due mainly to the variation in maintenance and repairs, and depreciation. Depreciation changes were caused mainly by plants' fiscal years ending at times other than the calendar year. All purchases of equipment during the year, however, also affected the monthly depreciation totals. Maintenance and repairs were a little higher when plants operated near capacity, but remained relatively constant throughout the year.

Because there was little change in the total building and equipment costs throughout the year, unit costs showed substantial variation. The average unit building and equipment cost during

Table 8. Average total building and equipment cost per month and per 100 pounds of milk processed at six South Dakota manufacturing plants, 1963.

	A	B	C	D	E	F	Weighted* Average
	- - - - - - - - - - - Amount per month - - - - - - - - - - -						
Total Cost of Dep. Ins. & Taxes, Repairs:							
Three high volume months	14,936	8,211	6,447	5,221	8,942	6,275	9,459
Three low volume months	14,403	7,948	6,216	5,181	6,457	6,734	8,793
Average volume months	14,858	8,330	6,369	5,276	8,165	6,358	9,291
Total Cost of Dep.:							
Three high volume months	11,356	6,590	4,670	4,334	5,259	4,950	7,134
Three low volume months	9,991	6,342	4,804	4,327	5,157	5,038	6,564
Average volume months	10,989	6,441	4,816	4,358	5,228	4,910	6,939
Total Cost of Ins. & Taxes:							
Three high volume months	1,886	973	682	528	1,610	795	1,192
Three low volume months	2,132	1,001	694	492	869	795	1,235
Average volume months	2,002	1,007	588	519	1,222	800	1,168
Total Cost of Main. & Rep.:							
Three high volume months	1,694	648	1,095	359	2,073	530	1,113
Three low volume months	2,280	605	708	361	431	901	1,070
Average volume months	1,866	902	965	399	1,715	648	1,182
	- - - - - - - Amount per 100 pounds of milk - - - - - - -						
Unit Cost of Building & Equipment:							
High	.106	.075	.092	.131	.179	.089	.104
Low	.180	.114	.124	.173	.215	.168	.156
Average	.135	.093	.106	.144	.204	.127	.166

* Weighted against the volume of milk.

the months of high volume amounted to 10.4 cents. The average unit cost of the low volume months was 15.6 cents or a difference of 5.2 cents per hundred pounds of milk. During the month of average receipts, the range for the individual plants was from 9 cents to 20 cents per hundred pounds of milk manufactured.

Administrative Expense

Administrative expenses combined made up only 15 percent of the cost of manufacturing milk in the six plants studied. Administrative expenses in 1963 during the months of normal production amounted to 4.5 cents per hundred pounds of milk.

Administrative expenses include production overhead, office supplies, telephone, travel expense, and miscellaneous. Production overhead includes monthly audits, bank charges, quality control, and various other items depending on the particular organization.

The items included under administrative expense are generally of a fixed nature and the total expense does not vary much with production. This causes the unit cost to vary as production changes and greater production lowers unit costs.

For all plants, administrative costs were lowest during the heavy production months (Table 9). The weighted average was from .039 cents per hundred pounds of milk during months of heavy production to .057 cents per hundredweight of milk handled in the low volume months.

Table 9. Average total administrative expenses and cost per 100 pounds of milk processed at six South Dakota manufacturing plants, 1963.

Item	A	B	C	D	E	F	Weighted* Average
	- - - - - - - - - - Average per month - - - - - - - - - -						
Total Administrative Expenses:							
Three high volume months	2,951	4,403	2,271	3,036	3,535	3,347	3,306
Three low volume months	2,484	3,733	2,473	2,543	2,498	3,244	2,873
Average volume months	2,763	4,009	2,168	2,737	2,733	3,278	3,019
	- - - - - - - - Amount per 100 pounds of milk - - - - - - - -						
Cost per 100 Pounds of Milk:							
Three high volume months	.021	.039	.031	.068	.074	.048	.039
Three low volume months	.031	.056	.050	.078	.088	.080	.057
Average volume months	.025	.045	.038	.071	.071	.062	.045

* Weighted against the volume of milk.

Table 10. Average total cost of operating supplies and cost per 100 pounds of milk processed at six South Dakota manufacturing plants, 1963.

Item	A	B	C	D	E	F	Weighted* Average
	- - - - - - - - - - Average per month - - - - - - - - - -						
Total Cost:							
Three high volume months	11,628	8,699	4,354	5,690	4,761	3,164	6,004
Three low volume months	2,401	4,945	4,394	3,041	1,723	1,735	3,229
Average volume months	6,905	6,701	2,690	4,325	5,038	3,247	5,284
	- - - - - - - Amount per 100 pounds of milk - - - - - - -						
Cost Per 100 Pounds of Milk:							
Three high volume months	.083	.078	.061	.128	.100	.045	.078
Three low volume months	.029	.073	.089	.093	.060	.042	.060
Average volume months	.063	.075	.047	.112	.131	.061	.075

* Weighted against the volume of milk.

Operating Supplies

Table 10 shows the total and unit costs of operating supplies for each plant. Operating supplies included brushes, soap, detergents, lubricants, laboratory materials, and packaging materials. The largest single item was packaging materials. Supply costs varied according to plant size and volume. Larger quantities of supplies were needed when the plant operated at or near capacity.

It was found in five of the six plants that during the months of low volume, unit costs were "lower" than during months at high volume. It appears that there is a high positive correlation between the amount of supplies needed and the volume of milk handled. Unit costs for the high-volume months averaged 7.8 cents, while cost per hundred pounds of milk during the low months was only 6 cents, or a difference of nearly 1.8 cents.

Total Plant Operating Costs

All unit costs discussed in this chapter are stated in terms of the common denominator of a hundredweight of milk received and processed into butter and powder. Table 11 summarizes the five classifications of costs for each plant during high, low and average volume months.

For the six plants the average total operating cost was $33,613 during months of normal operation. The range of total costs varied from a seasonal low of $28,843 to a high, during months of greatest volume, of $37,080. The range of unit costs,

Table 11. Summary of the average monthly plant operating costs and cost per 100 pounds of milk processed at six South Dakota manufacturing plants, 1963.

Item	A	B	C	D	E	F	Weighted* Average
Total Operating Cost:							
Three high volume months	56,620	36,618	26,172	26,604	28,369	21,844	37,080
Three low volume months	42,679	29,832	24,931	20,255	19,083	18,095	28,843
Average volume months	52,629	33,565	21,327	23,612	26,602	20,217	33,613
	- - - - - - - - - - Amount per 100 pounds - - - - - - - - - -						
Cost per Hundred Pounds of Milk:							
Three high volume months	.405	.330	.368	.614	.588	.314	.406
Three low volume months	.532	.440	.504	.639	.660	.448	.537
Normal volume months	.479	.376	.370	.625	.678	.389	.504

* Weighted against the volume of milk.

however, were exactly the opposite. The average unit cost was 50 cents during months of normal volume, 53.7 cents during lowest production, and only 40.6 cents per hundredweight of milk during months of highest receipts.

Wide variations are recognized between plants, as to the differences in unit costs. As a whole the larger plants experienced the greatest variations in unit costs from months of high volume to months of low volume. The lowest unit costs, however, are in the largest plants. Plants on a smaller scale have less seasonal variation, but are confronted with higher unit costs. The volume of milk handled then does appreciably effect the costs incurred per hundred pounds of milk manufactured. Milk receipts and unit costs were inversely related.

Table 12 breaks down the five categories of costs into fixed, variable, and semi-variable costs. Fixed costs were considered as those costs that were not affected by the seasonal variations of milk receipts. Included as fixed costs were building and equipment cost, and administrative cost. Variable costs are those costs that were found to change considerably as milk receipts varied. Included in this classification were fuel, electricity, and water cost, and the cost of operating supplies. Due to the variability of these costs, unit costs show little change from months of high receipts to months of low receipts.

Table 12. Summary of total unit costs classified as fixed, semi-variable or variable at six South Dakota milk manufacturing plants, 1963.

Item	A	B	C	D	E	F	Weighted* Average
FIXED COSTS							
Unit Building and Equipment Cost:							
Three high volume months	.106	.075	.092	.131	.179	.089	.104
Three low volume months	.180	.114	.124	.173	.215	.169	.156
Average volume months	.135	.093	.106	.144	.204	.127	.166
Unit Administrative Costs:							
Three high volume months	.021	.039	.031	.068	.074	.048	.039
Three low volume months	.031	.056	.050	.028	.088	.080	.057
Average volume months	.025	.045	.038	.071	.071	.062	.045
VARIABLE COSTS							
Unit Fuel, Electricity and Water Cost:							
Three high volume months	.062	.052	.069	.144	.088	.084	.073
Three low volume months	.078	.065	.100	.141	.104	.107	.091
Average volume months	.074	.061	.079	.145	.103	.093	.088
Unit Operating Supplies:							
Three high volume months	.083	.078	.061	.128	.100	.045	.078
Three low volume months	.029	.073	.089	.093	.060	.042	.060
Average volume months	.063	.075	.047	.112	.131	.061	.075
SEMI-VARIABLE COSTS							
Unit Labor Costs:							
Three high volume months	.133	.086	.115	.143	.147	.048	.112
Three low volume months	.214	.132	.141	.154	.193	.051	.163
Average volume months	.182	.102	.100	.153	.169	.046	.130

As previously explained, a major portion of labor cost was fixed because of the structural framework of labor in a manufacturing plant. If a microscopic analysis was made of labor, it would reveal that a large part of the cost is fixed, a part that is not immediately variable, and a very small part, for example: overtime, that is completely variable. Lacking criteria for breaking down labor into these three categories, all labor was classified as semi-variable, that is not substantially variable from day to day, but seasonally adjustable.

Butter and Powder Manufacturing Costs

Tables 13 and 14 show the total pounds of butter and powder produced by each plant in the year 1963. The purpose of these tables and Tables 15 and 16 is to show how the total and unit costs were distributed between the dairy and drying operations in each plant.

From Tables 13 and 14, butter and powder production are shown to vary considerably, as does the volume of milk receipts. In the larger plants, the number of pounds of butter and powder produced during months of low milk receipts averaged only 57 percent of what was manufactured during months of high receipts. The smaller plants, D, E, and F, also showed wide variations in production, but less than the large plants. The production of butter

Table 13. Total pounds of butter manufactured per month at six South Dakota milk manufacturing plants, 1963.

Plant	Jan.	Feb.	Mar.	Apr.	May	June
A	448,538	485,585	454,115	465,517	517,214	452,501
B	214,404	246,684	316,635	327,222	323,652	305,522
C	228,696	225,405	259,871	263,113	288,705	278,033
D	166,520	174,996	198,439	206,506	218,400	216,525
E	169,010	165,408	213,480	217,404	216,198	198,263
F	-0-	-0-	-0-	-0-	-0-	-0-

	July	Aug.	Sept.	Oct.	Nov.	Dec.
A	293,622	209,717	249,573	218,955	257,371	330,261
B	306,997	164,043	225,537	180,253	228,427	266,175
C	265,176	242,037	207,411	208,451	203,710	232,838
D	224,974	205,532	172,488	170,622	168,025	169,785
E	177,537	146,633	127,358	127,310	127,462	148,797
F	-0-	-0-	-0-	-0-	-0-	-0-

Table 14. Total pounds of powder manufactured per month at six South Dakota milk manufacturing plants, 1963.

Plant	Jan.	Feb.	Mar.	Apr.	May	June
A	918,882	1,126,039	974,600	1,072,570	1,333,900	1,199,900
B	795,014	779,148	857,780	860,836	1,026,082	1,003,183
C	407,000	419,700	485,600	522,000	574,000	566,400
D	249,100	249,270	331,841	474,669	480,000	501,558
E	318,500	316,200	384,900	391,950	400,400	375,950
F	429,816	460,390	473,715	530,120	606,580	650,040

	July	Aug.	Sept.	Oct.	Nov.	Dec.
A	1,007,750	954,150	759,900	667,800	683,750	850,350
B	914,976	845,871	582,687	642,619	606,845	711,260
C	520,000	489,600	427,300	425,200	408,400	429,100
D	496,184	429,986	257,000	260,873	266,700	267,642
E	322,300	269,200	231,970	240,150	247,750	280,200
F	555,960	527,060	236,789	359,605	360,200	377,100

Table 15. Average total cost of butter manufacturing and cost per 100 pounds of milk processed at six South Dakota milk manufacturing plants.

Item	A	B	C	D	E	F	Weighted* Average
	- - - - - - - - - - - - Average per month - - - - - - - - - - - -						
Total Cost of Butter Mgf.:							
Three high volume months	20,660	15,973	11,063	8,374	13,811	- - -	15,685
Three low volume months	21,106	12,941	10,623	7,446	8,746	- - -	13,884
Average volume months	23,355	14,569	10,280	8,103	12,669	- - -	15,670
	- - - - - - - - - - - Amount per 100 pounds - - - - - - - - - - -						
Cost Per 100 Pounds of Milk:							
Three high volume months	.148	.144	.175	.231	.291	- -	.162
Three low volume months	.229	.193	.246	.249	.318	- -	.232
Average volume months	.193	.160	.191	.240	.315	- -	.204

* Weighted against the volume of milk.

Table 16. Average total cost of powder manufacturing and cost per 100 pounds of milk processed at six South Dakota milk manufacturing plants.

Item	A	B	C	D	E	F	Weighted* Average
	- - - - - - - - - - - - Average per month - - - - - - - - - - - -						
Total Cost of Powder Mgf.:							
Three high volume months	36,955	20,427	12,829	16,686	14,130	22,144	23,443
Three low volume months	24,663	16,557	11,588	11,290	9,702	17,347	16,579
Average volume months	32,800	20,673	11,599	14,166	13,743	18,828	21,082
	- - - - - - - - - Amount per 100 pounds of milk - - - - - - - - -						
Unit Cost:							
Three high volume months	.253	.187	.190	.378	.297	.314	.251
Three low volume months	.302	.247	.256	.390	.342	.448	.312
Average volume months	.289	.213	.211	.389	.359	.388	.301

* Weighted against the volume of milk.

and powder during months of low milk receipts in the smaller plants averaged 63 percent of the production during the months of high receipts.

Tables 15 and 16 show the breakdown of costs. In all but one plant the drying operation incurred greater costs than the dairy. The range of average total costs of butter manufacturing was $13,884 during months of low volume to $15,685 during high volume months. The average cost during months with average milk receipts was $15,670. Unit costs of butter manufacturing ranged from 16 cents in the high volume months to 23 cents during the months of low receipts.

Cost fluctuations of butter and powder manufacturing were found to follow similar patterns. The average total cost of the drying operation in all six plants was $21,022 during the months of average milk receipts. The range in the total cost of manufacturing powder was from $16,579 during months of low receipts to $23,443 when receipts were high. Total unit costs varied 6 cents. The lowest unit cost for all plants was 25 cents when receipts were high. During months of low receipts, unit costs rise to a high of 31 cents.

CHAPTER IV

A COMPARISON OF IN-PLANT COSTS BY MAINTAINING MILK RECEIPTS AT SEASONAL, AVERAGE, AND PEAK LEVELS

The previous chapter showed the variations of in-plant costs under conditions of high, low, and average milk receipts. In all plants, as milk receipts increased, unit costs decreased; and as milk receipts decreased, unit costs increased.

The purpose of the following analysis is to examine the probable savings incurred when equal amounts of milk are produced at the average and peak levels throughout the year, and to determine the extent to which in-plant savings per hundredweight of milk can be passed on to producers in the form of higher prices.

In-Plant Costs and Peak Receipts[16]

An analysis of the six dairy manufacturing plants shows that if the plants were to manufacture milk with peak receipts each month of the year, 22 percent or nearly 110 million more pounds of milk could be manufactured annually than under seasonal milk procurement policies. The increase in milk receipts would increase in-plant labor costs only 11 percent (Table 17). While considerable

---

[16] The term peak receipts is used only for convenience. Peak receipts and average monthly receipts during the months of highest volume are synonymous.

Table 17. Increase in milk receipts and total costs by operating with peak receipts at six South Dakota milk manufacturing plants, 1963.

Item	A	B	C	D	E	F	Total Increase of All Plants
				Million pounds			
Increase in Milk Volume	36	27	15	7	11	17	113
				Percent			
Percent increase	27	25	22	15	25	26	25
				Thousands of dollars			
Increase in Total Operating Costs	66	39	33	37	38	21	234
				Percent			
Percent increase	11	10	12	13	13	9	11

variation exists among plants, the increase in amount of milk processed annually when processing with peak receipts each month would be much greater than the increase in in-plant costs.

If the six dairy manufacturing plants were run with peak receipts each month of the year, an average saving of 6 cents per hundredweight of milk could be expected over present seasonally fluctuating milk receipts. Savings in in-plant unit costs ranged from a low of 1.2 cents in Plant D to 7.1 cents in Plant F. A comparison of in-plant costs per hundredweight of milk with seasonally fluctuating receipts and peak monthly milk receipts are shown in Table 18. As shown, manufacturing equal monthly volumes of milk at peak levels throughout the year could increase the efficiency of the firm because of the decrease in in-plant costs.

In-Plant Costs and Average Receipts

A program initiated to level out present seasonal milk receipts would not increase total annual milk output. Milk received at the plant level would be very similar in amounts as at present but received in equal monthly amounts.

In three of the six plants no appreciable gains would be experienced in unit costs by leveling out the present seasonal milk receipts. Plants A, E, and F would show increases in unit costs, while B, C, and D's unit costs would decrease, but only slightly.

Table 18. A comparison of in-plant unit costs under conditions of seasonally fluctuating, even, and peak monthly milk receipts at six South Dakota milk manufacturing plants, 1963.

Item	A	B	C	D	E	F	Weighted* Average
	- - - - - - - - - - Cost per 100 pounds of milk - - - - - - - - - -						
Seasonal Receipts Unit Costs	.475	.381	.403	.626	.651	.385	.466
Peak Receipt Unit Costs	.405	.330	.368	.614	.588	.314	.406
Change in Unit Costs	.070	.051	.035	.012	.063	.071	.060
	- - - - - - - - - - - - - - - - Percent - - - - - - - - - - - - - - - -						
Percent Change	15	13	9	2	10	18	14
	- - - - - - - - - - Cost per 100 pounds of milk - - - - - - - - - -						
Average Receipt Unit Costs	.479	.376	.370	.625	.678	.389	.466
Change in Unit Cost	-.04	.5	3.3	.1	-2.7	-.4	0
	- - - - - - - - - - - - - - - - Percent - - - - - - - - - - - - - - - -						
Percent Change	+1	+1	-8	0	+4	+1	0

* Weighted against volume of milk.

Table 18 indicates that leveling present receipts will neither decrease or increase average unit costs for all six plants. Although there is slight variation within each plant over a 12 month period the increases and decreases balance out eliminating any appreciable change.

Economic Implications

Milk buying programs aimed at evening out milk receipts at peak levels would undoubtedly incur additional expenses such as the need to pay premium prices for additional milk during seasons of low milk supply. The price incentives would evolve from the savings that resulted from increasing milk receipts in each plant. Table 18 indicates the savings in each of the six plants.

In South Dakota, milk prices during each of the three distinct marketing seasons remain relatively constant from year to year (Table 19).[17] The results of operating with peak receipts indicates an increase in efficiency due to the decrease in unit costs. In some states, milk prices can vary seasonally by as much as 60 cents per hundredweight of milk.[18] This is not the case in South Dakota. As shown in Table 19, the average milk price of

---

[17] Milk prices in South Dakota are relatively constant in comparison to the large variations in other states.

[18] Op. cit., Fitzpatrick, p. 110.

Table 19. Wholesale manufacturing milk prices, South Dakota.

Month	1958-62 Average	1963	1964
	- - - - - Dollars per 100 pounds - - - - -		
January	3.05	3.10	3.15
February	3.03	3.05	3.10
March	2.99	3.05	3.10
April	2.93	3.00	3.05
May	2.88	3.00	3.00
June	2.84	2.95	2.95
July	2.88	3.05	3.05
August	2.91	3.05	3.05
September	3.00	3.10	3.10
October	3.08	3.10	3.20
November	3.12	3.15	3.25
December	3.12	3.15	3.25
Year	2.99	3.05	3.10

Source: South Dakota Crop and Livestock Reporting Service, April 1965.

Table 20. Premiums available through savings in in-plant costs at six South Dakota milk manufacturing plants, 1963.

Plant	Cents per hundredweight of milk
A	33
B	25
C	20
D	10
E	32
F	32
Weighted Average	29

1964 has increased only 11 cents above the 1958-62 average. Seasonal changes throughout the last few years have not exceeded 25 cents.

Relatively stable prices indicate the ability with average savings of 6 cents per hundredweight of milk manufactured to increase milk receipts to a level of peak receipts that exist now only three months of the year. If large price variations existed, it is doubtful that a savings of 6 cents per hundredweight of milk manufactured would be sufficient to attempt increasing receipts. For the six South Dakota dairy manufacturing plants, in-plant savings through manufacturing at peak levels each month would be sufficient to allow 29 cents per hundredweight to be paid for supplemental milk supplies over and above seasonal prices for milk (Table 20).

Plants A, E, and F, with peak receipts each month of the year, are capable of increasing prices over 30 cents per hundredweight of milk. Plant A is high at 33 cents while E and F are at 32 cents. What is significant is that the greater the savings incurred by leveling out monthly receipts at peak levels, the larger the incentive that can be added to present prices. Plants B, C, and D would also realize substantial price-raising possibilities if production was increased as well as evened out. The range is from a low of 10 cents in Plant D to a high of 25 cents in Plant B.

Further research is needed to determine if this increase in prices is sufficient to increase milk receipts. The plants are capable of operating annually with peak receipts, but are the suppliers capable of producing the increased amount? Research aimed at producers' attitudes is needed in this area.

Reliability of the Results

The analysis of in-plant costs throughout this study is based on five South Dakota butter-powder plants and one powder plant. The six plants include all of the butter-powder plants in South Dakota. Generalizations are subject to the limitations which may accompany this case study approach. To fulfill the needs of the study this approach was considered most appropriate to obtain the detailed information of in-plant costs.

It was assumed that equal monthly amounts of milk could be manufactured in these plants each month of the year. In actual practice, equal receipts may not be possible. Daily variations are sure to always exist. The results, however, are considered the best projection of what could possibly happen if the plants could change the present seasonal pattern of milk receipts. The amount of in-plant costs may not change exactly as predicted, but the direction and proportion of change would be similar to that described.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

Milk is produced in quantities that vary from month to month. This study examined the costs of processing milk in six South Dakota milk manufacturing plants. Specifically, the effect of seasonal volumes of receipts upon cost of manufacture was studied and analyzed. Only in-plant costs were included, procurement and marketing costs were excluded.

Cost data were obtained by the use of a questionnaire and personal interview. Detailed records of milk receipts and in-plant costs were obtained from each plant for the year, 1963. In addition to costs, an interview with each plant manager was conducted to determine the magnitude of the seasonal milk production problem.

In general, seasonal variations in the production of milk for manufacturing purposes is considered a problem by manufacturers. To reduce seasonality, incentive plans would have to be introduced by the South Dakota plants. Since the greatest savings seemed to lie in in-plant costs, an analysis of these costs appeared essential to supply manufacturers with needed information.

Past studies were reviewed to gain an insight into the impact of seasonality on in-plant costs. Studies reviewed showed the seasonality of milk receipts in various sections of the country. The relationship of in-plant costs to volume of milk receipts was verified by this review.

Monthly milk receipts for the six plants ranged from a high of 13,975 million pounds to a low of 2,836 million pounds. Two plant's milk receipts during the months of highest volume were more than 10 million pounds of milk each month, two received more than 6 million pounds and the two smallest plants received over 4 million pounds. The seasonal receipts followed a pattern of low milk production in the fall and winter months and high production in the spring. The number of pounds received by all plants during months of lowest production averaged close to 4 million pounds less per month than during months of high receipts.

In-plant costs per hundredweight of milk averaged 46.6 cents with present seasonal procurement. During months of highest production unit costs dropped to 40.6 cents and rose to 52.7 cents per hundredweight during months of lowest receipts. By operating at peak capacity the entire twelve months, an average savings of 6 cents per hundredweight of milk would be available. The range in in-plant savings is from 7.1 cents per hundredweight of milk processed to 1.2 cents per hundredweight.

If it were possible to even out milk receipts at peak capacity, 113 million more pounds of milk would be manufactured annually. This represents an increase of 25 percent. The results of operating twelve months of the year with peak receipts is an increase in efficiency due to a decrease in unit costs. Further research would indicate whether the savings were large enough to increase production close to the maximum.

Conclusions

The conclusions of this study are:

1. Operating at a peak level of milk manufacturing each month of the year, instead of only 3 months of the year, will introduce savings sufficient to offset any additional costs that may be incurred to handle the increased milk supply. Average in-plant savings through manufacturing with peak receipts each month of the year would be large enough to enable 29 cents per hundredweight to be paid for supplemental milk supplies over and above seasonal prices for milk. The results are such that dairy plants in South Dakota should investigate the possibilities of initiating one of several incentive programs.
2. It is doubtful that any savings can be realized by only evening out the present supply of milk. There is no indication that a plan initiated to just level out the

present supply is a worthwhile investment. Increased plant efficiency, if any, would not warrant such action.

LITERATURE CITED

Bartlett, R. W. and Gothard, F. I., Measuring Efficiency of Milk Plant Operation, Bulletin 560 (University of Illinois, Nov., 1952).

Fitzpatrick, John M., Impact of Seasonality of Milk Supplies on Labor Costs and Efficiency in Dairy Manufacturing Plants, (Ph.D. dissertation, Purdue University, Lafayette, Indiana, 1963).

Frazer, J. R., Nielsen, V. H., and Nord, J. D., The Cost of Manufacturing Butter, Research Bulletin 389 (Iowa State College, June, 1952).

Johnson, A. C., Forker, O. D., and Clarke, D. A., Operations and Costs of Manufacturing Dairy Products in California, Gianni Foundation Research Report No. 272 (California Agricultural Experiment Station, Berkeley, California, Jan., 1964).

LaCasse, A. and Spencer, L., Costs and Efficiency in the Operation of Milk Manufacturing Plants in the New York-New Jersey Milkshed, A. E. - Res. - 26 (Department of Agricultural Economics, Cornell University, Ithaca, New York, 1960).

Nichols, W. H., Imperfect Competition Within Agricultural Industries, (Iowa State College Press, Ames, Iowa, 1941).

Owens, T. R. and Clark, D. A., Class III Milk in the New York III-Costs of Manufacturing Dairy Products, Marketing Research Report No. 400, (U. S. Department of Agriculture, Agriculture Marketing Service, 1958).

South Dakota Crop and Livestock Reporting Service, South Dakota Agriculture, 1963.

Walker, S. H., Preston, H. J., and Nelson, G. T., An Economic Analysis of Butter-Nonfat Dry Milk Plants, Bulletin No. 20 (Western Regional Research Publication, University of Idaho, June, 1953.